GEOLOGICAL SURVEY
UNIVERSITY OF MINNESOTA

MISCELLANEOUS MAP SERIES
MAP M-39

Base from U.S. Geological Survey, 1959

SCALE 1:24 000

1 MILE

1 KILOMETER

Geology 1966-68, 1970 and 1977

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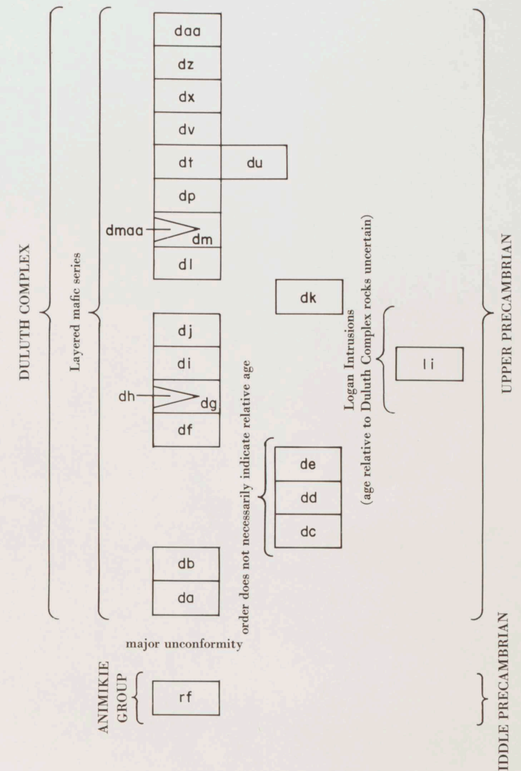
EXPLANATION

CORRELATION OF MAP UNITS



DULUTH COMPLEX (UPPER PRECAMBRIAN—KEWEENAWAN)

daa, *red, medium-grained, granular quartz (18%)—alkali feldspar (77%) rock containing minor augite (3%) and titanium-iron oxides (2%). Equivalent to unit gpy of Davidson (1977) in the Lima Mountain quadrangle.*

dz, *fine-grained, decussate quartz (10%)—orthoclase (15%)—hornblende (29%)—plagioclase (34%) rock containing interstitial titanium-iron oxides (9%) and minor augite (3%).*

dx, *brown or black, fine-grained to aphanitic augite (22%)—plagioclase (66%) rock containing diagnostic local plagioclase phenocrysts; in coarser-grained specimens, some olivine (2%) present. Titanium-iron oxides (7%) are most abundant minor minerals, olivine (2%) and quartz (2%) are common, and apatite and alkali feldspar (1%) are uncommon accessory minerals.*

dv, *dark gray, coarse-grained, granular titanium-iron oxides (23%)—augite (44%) rock containing interstitial olivine (1%)—plagioclase (8%), and pigeonite (24%).*

dt, *black, medium-grained, granular olivine (16-36%)—titanium-iron oxide (57-73%) rock. Varietal minerals include plagioclase (2-10%) and augite (0-1%); apatite, pigeonite, and hornblende are uncommon accessories. Unit is characterized in outcrop by distinctive malachite staining.*

du, *brown, medium-grained, granular plagioclase (21%)—titanium-iron oxides (24%)—olivine (49%) rock; plagioclase is interstitial. Augite (4%), hypersthene (2%), and apatite are minor minerals; titanomagnetite is more abundant than ilmenite.*

dp, *fine-grained, foliated augite (32%)—plagioclase (58%) rock characterized by five-millimeter brown olivine phenocrysts (3%) and one-centimeter brown hypersthene oikocrysts (7%). Titanium-iron oxides are minor minerals.*

dm, *coarse-grained, decussate to weakly foliated pigeonite (13%)—titanium-iron oxide (2%)—augite (24%)—plagioclase (59%) rock. Most common facies contains quartz (1%), alkali feldspar (1%), and apatite or magnesian olivine. Uncommon plagioclase-rich facies are white and plagioclase-rich patches in the pyroxene-bearing facies give the rock a mottled appearance. Pyroxenes are prominent as oikocrysts in the plagioclase-rich facies. Equivalent to unit olg of Davidson (1977) in the Eagle Mountain quadrangle.*

dmaa, *gray, mottled pale pink and green, coarse-grained, decussate, pigeonite-augite-plagioclase rock characterized by quartz-alkali feldspar mesostasis near contacts with unit daa.*

dl, *medium-grained, decussate pigeonite (17%)—augite (20%)—plagioclase (60%) rock containing minor interstitial titanium-iron oxides (1%), quartz (1%) and alkali feldspar (1%). Hypersthene and augite have exsolved from pigeonite. Biotite occurs as a minor alteration mineral.*

dk, *dikes, pink, fine-grained, granular hornblende-titanium-iron oxides-plagioclase-quartz-orthoclase rock. Other dikes mapped as part of this unit, but probably not cogenetic with it include pink to gray, fine-grained, decussate chlorite-biotite-quartz-alkali feldspar rock. All occurrences are near the base of the Duluth Complex.*

dj, *white, coarse-grained, foliated augite (6-17%)—plagioclase (67-83%) rock containing minor titanium-iron oxides (4-15%). Pyroxenes form large oikocrysts and titanium-iron oxides occur in small lenses. Quartz (1%), alkali feldspar (2%), pigeonite (1-4%) and apatite are minor minerals. Some deuteric alteration of plagioclase and pyroxene.*

di, *gray, fine-grained, decussate, titanium-iron oxide (23%)—augite (28%)—plagioclase (45%) rock containing minor olivine (2%) and apatite (2%).*

dh, *gray to brown, fine-grained, foliate titanium-iron oxides (4%)—olivine (20%)—plagioclase (66%) rock containing minor augite (5%), pigeonite (4%), and apatite (1%); has some deuteric biotite. Unit is distinguished from units da and dg by conspicuous titanium-iron oxides.*

dg, *coarse-grained, strongly foliated olivine-plagioclase or augite-plagioclase rock containing abundant titanium-iron oxides. Mineral abundances vary widely and density-graded layering is prominent. Major facies include titanium-iron oxides-olivine-plagioclase, titanium-iron oxides-augite-olivine-plagioclase, and titanium-iron oxides-augite-plagioclase rocks. Ilmenite is only oxide at the base, but titanomagnetite and ilmenite coexist throughout the remainder of the unit. Deuteric biotite is conspicuous and hydrothermal alteration of olivine and pyroxenes to amphibole and chlorite, with associated chalcopyrite, occurs locally.*

df, *fine- to coarse-grained, decussate augite (10%)—olivine (10%)—plagioclase (68%) rock. Interstitial pigeonite (5%) and ilmenite (7%) generally are abundant and quartz, apatite, and alkali feldspar are present in trace amounts. Deuteric biotite is a characteristic alteration mineral. Patches of quartz, alkali feldspar, and copper sulfides appear sporadically near the base of the unit.*

de, *brown, fine-grained, granodecussate augite (41%)—plagioclase (53%) rock containing accessory titanium-iron oxides (6%), pigeonite, and apatite.*

dd, *gray to brown, very fine grained, granular, moderately magnetic titanium-iron oxides-augite-plagioclase or olivine-titanium-iron oxides-augite-plagioclase rock. Unit is distinguished from unit dc by being more magnetic.*

dc, *gray to tan, very fine grained, granular to weakly foliated, weakly magnetic olivine-augite-plagioclase rock having local facies of pigeonite-augite-plagioclase or titanium-iron oxides-augite-plagioclase. Titanium-iron oxides, pigeonite, and apatite are sparse. Some deuteric biotite, amphibole, and chlorite are present.*

db, *medium-grained, strongly foliated rock containing black pyroxene (41%) and gray plagioclase (59%). Major facies include pigeonite-augite-plagioclase grading downward into augite-pigeonite-plagioclase with minor olivine present near base. Titanium-iron oxides and apatite are uncommon. Some pyroxene and all titanium-iron oxides are poikilitic; plagioclase phenocrysts occur locally. Gradational contact with unit da.*

da, *brown, fine-grained, foliated olivine-plagioclase (42-63%) rock containing rhythmic concentrations of olivine. Local facies contain plagioclase or augite phenocrysts. Pigeonite (3-9%) and augite (2-3%) locally abundant, whereas titanium-iron oxides and apatite are uncommon.*

LOGAN INTRUSIONS (UPPER PRECAMBRIAN—KEWEENAWAN)

li, *Fine- to coarse-grained, locally porphyritic diabase; contains heavily sericitized plagioclase (40-50%), augite-pigeonite (30-40%), magnetic-ilmenite (5-10%), and interstitial granophyric intergrowths. Augite and pigeonite intergrown in a mottled texture and commonly altered to amphibole and chlorite.*

ROVE FORMATION (MIDDLE PRECAMBRIAN)

rf, *Dominantly thin- to thick-bedded, and black, argillaceous siltstone interlayered with thin to thick beds of fine- to medium-grained, dark gray to very light gray feldspathic graywacke. Locally metamorphosed by the Logan Intrusions to a black, fine-grained, massive hornblende-hornfels, and by the Duluth Complex to a medium-grained, granoblastic pyroxene-hornfels.*

- Rock unit of uncertain or local extent; line shows approximate strike of dike. Duluth Complex only.
- Approximate areas of outcrop.
- Contact, showing dip—solid where known; long dash where approximate; short dash where gradational or inferred; dotted where concealed by water.
- Fault—long dash where approximate; short dash where inferred; dotted where concealed by water.
- 12 Strike and dip of inclined beds.
- 12 Strike and dip of foliation—includes mineral orientation and compositional layering in Duluth Complex.
- Grain lineation.
- Horizontal beds

GEOLOGIC MAP OF THE HUNGRY JACK LAKE QUADRANGLE, COOK COUNTY, MINNESOTA

By

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1977